



(D)OMI NO₂: the KNMI near-real time product

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Contents

- Purpose and context
- Near real-time retrieval algorithm
- Results
- Validation





Purpose (1)

- To provide users with near-real time air pollution monitoring
- Users include:
 - environmental agencies
 - air quality forecasters
 - GEMS (EU GMES) lead by ECMWF
 - PROMOTE (ESA GMES)
 - ...





Purpose 2

To generate a long-term consistent dataset from:

- GOME (1996-2003)
- SCIAMACHY (2003-)
- OMI (2004-)

KNMI retrieval algorithm for tropospheric NO₂

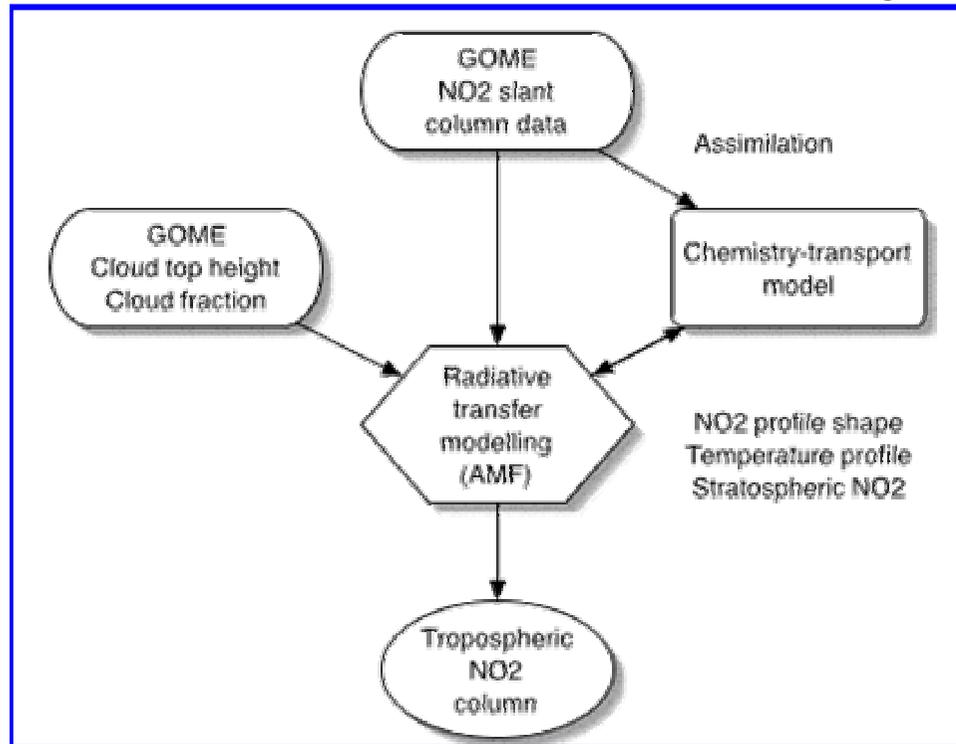
- Data publicly available via www.temis.nl
- Described in Boersma et al. (*JGR*, D04311, 2004)
- Lightning NO₂ production (*ACP*, **5**, 2005)



Near real time retrieval algorithm

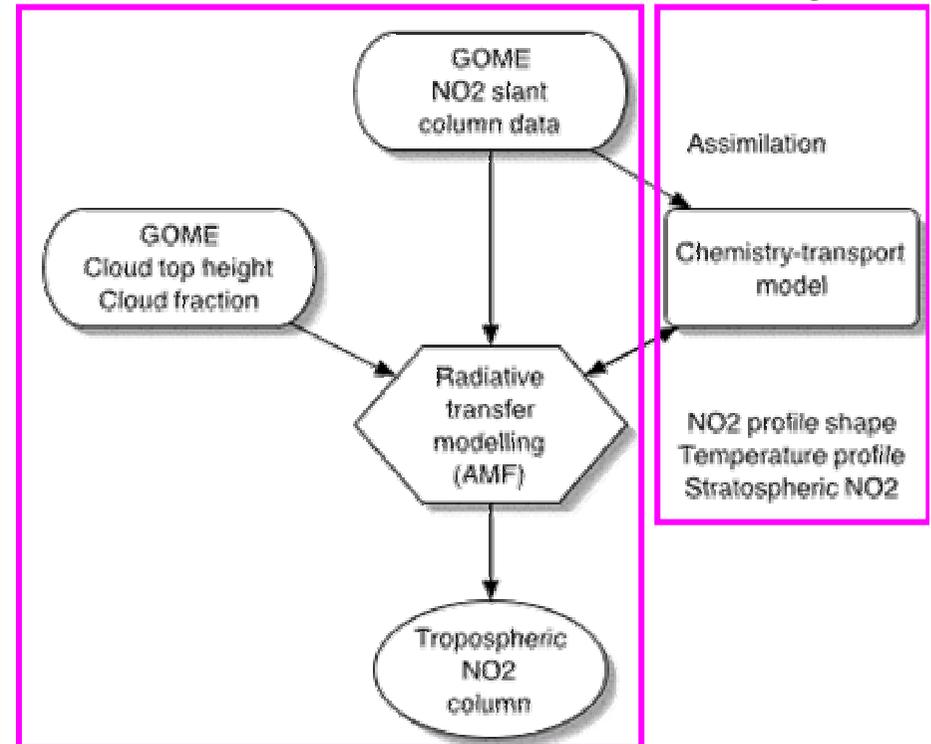
Post-processing (GOME/SCIA)

Retrieval/assimilation/modelling



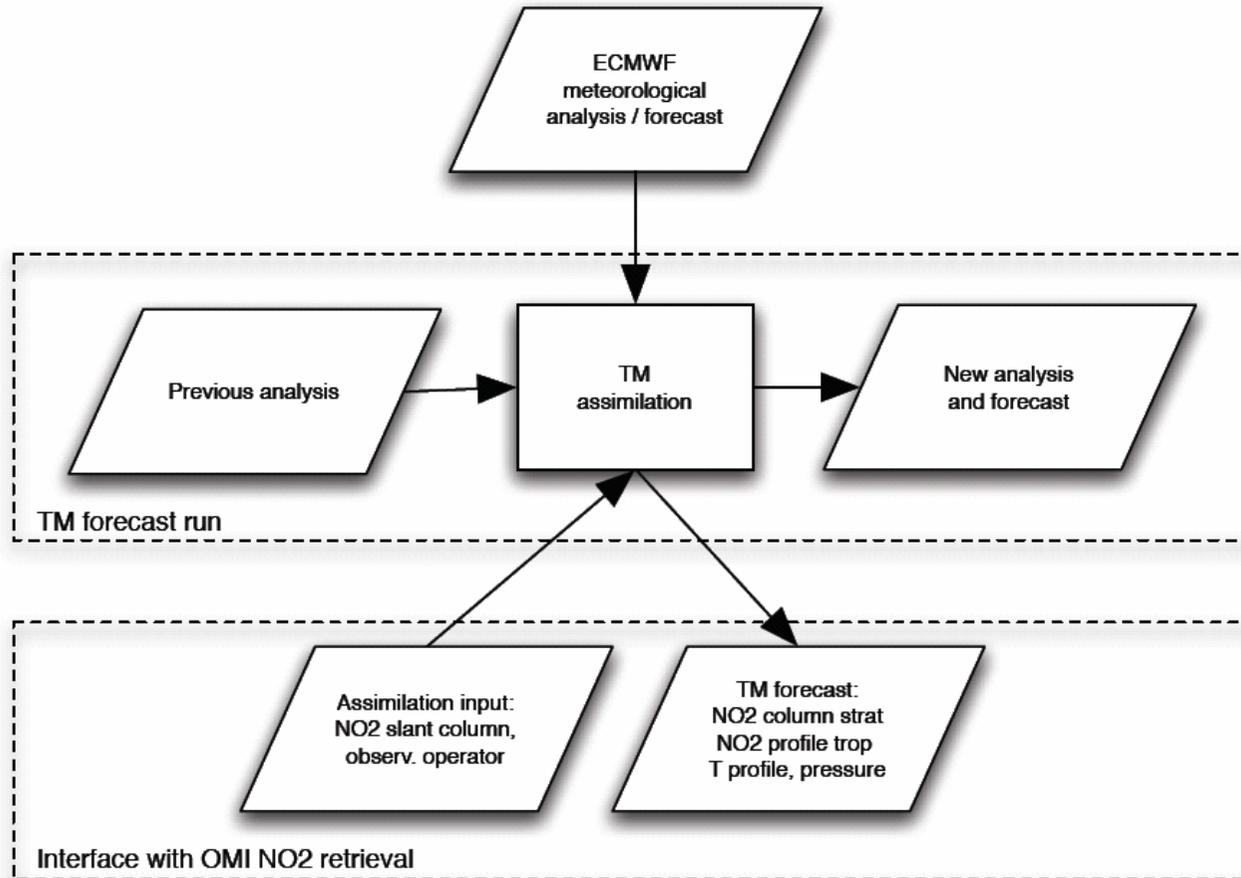
NRT (OMI)

Retrieval + assimilation/modelling



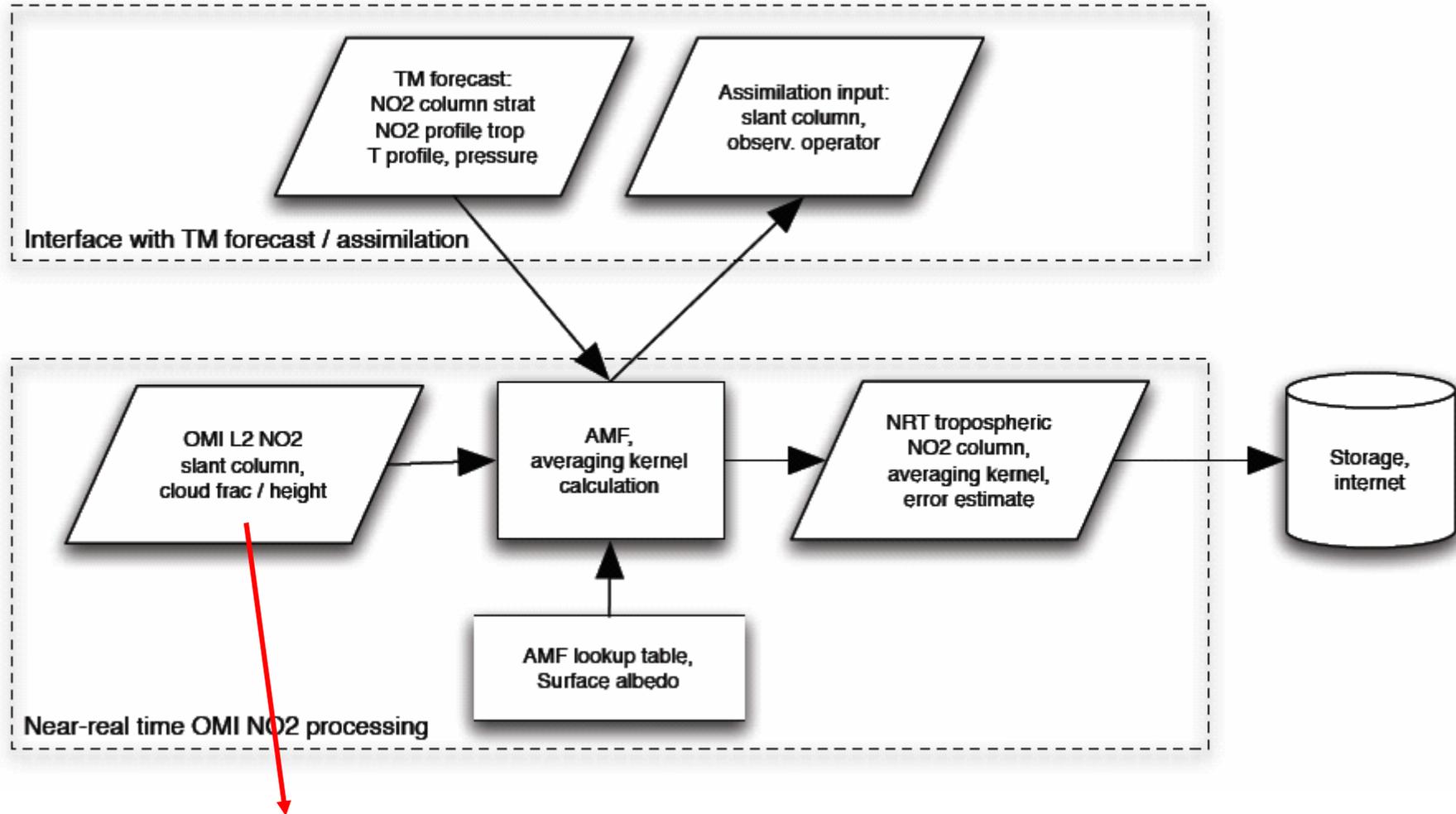


Branch 1: TM4 forecast





Branch 2: NRT retrieval



•••• NASA/KNMI DOAS algorithm

Folkert Boersma, EOS Aura Meeting, 8 november 2005



NRT retrieval 'operational' since 7 October 2005

Images available within ~2hrs (www.temis.nl/airpollution/)

- data acquisition
 - downlink
 - processing
 - KNMI/NASA DOAS algorithm
-

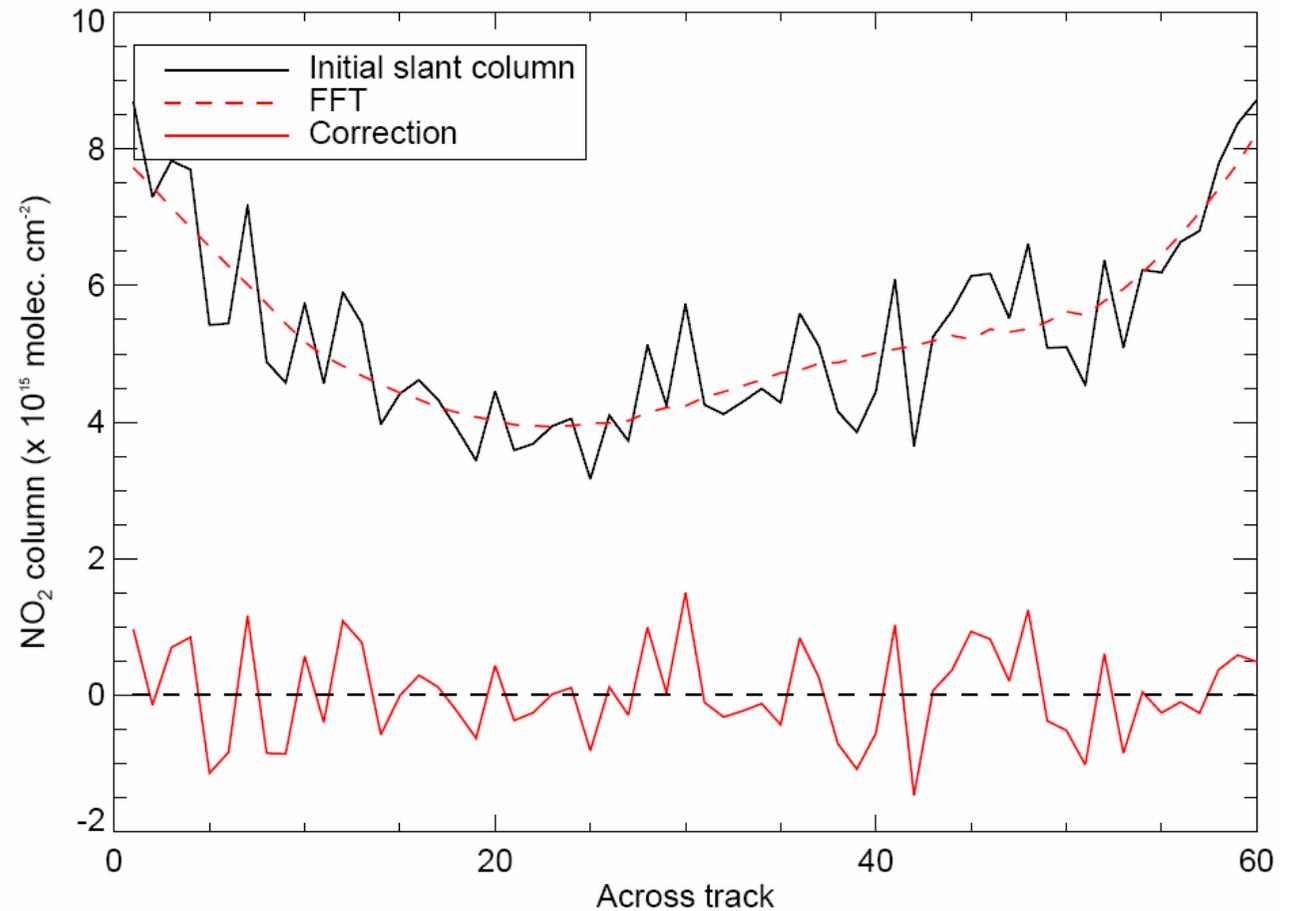
~2 hrs

- NRT processing time: < 2 minutes



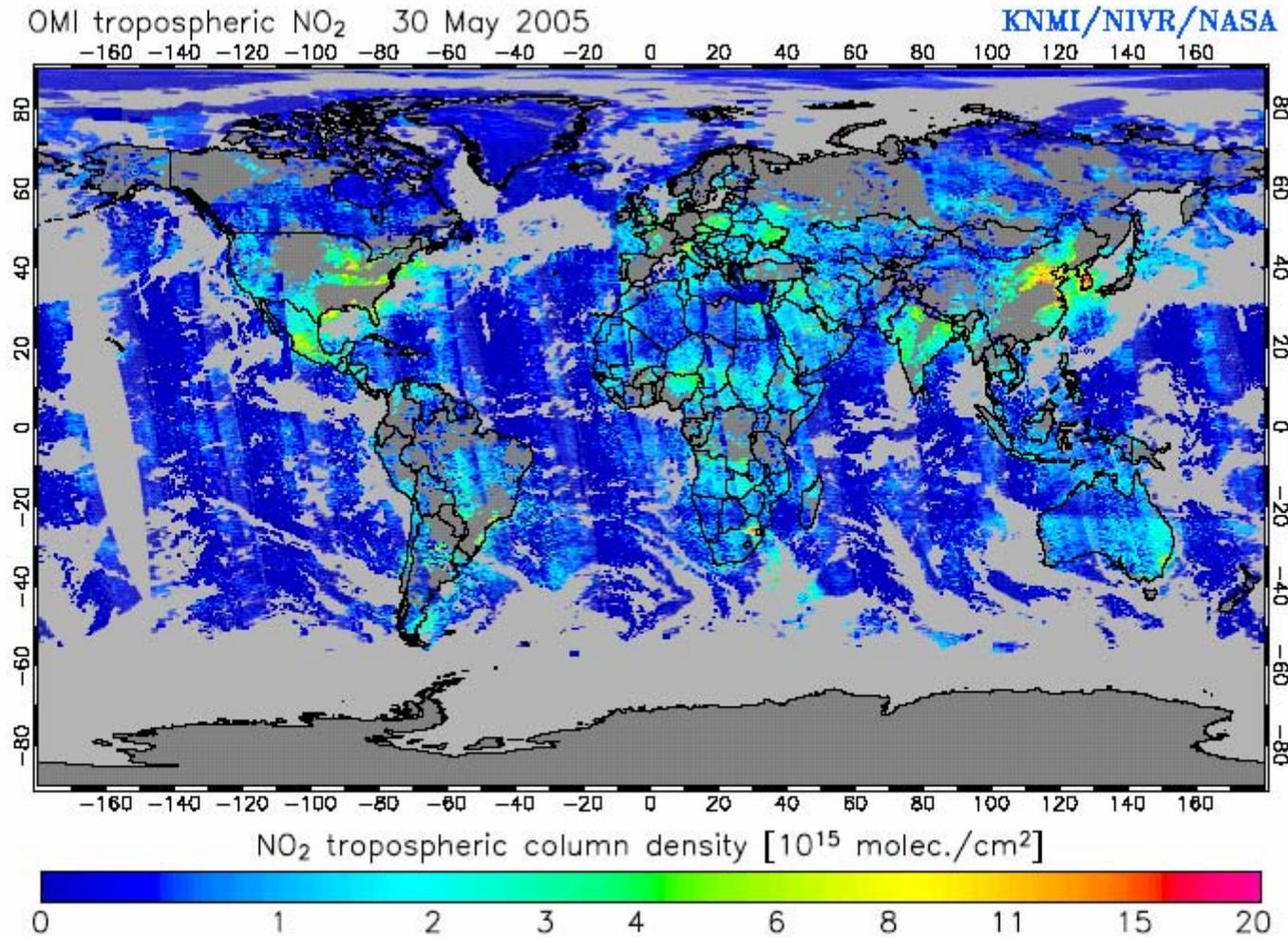
Stripe correction

1. Find window with smallest variation in initial columns
2. Compute mean column vs. across track viewing angle
3. FFT analysis to smooth





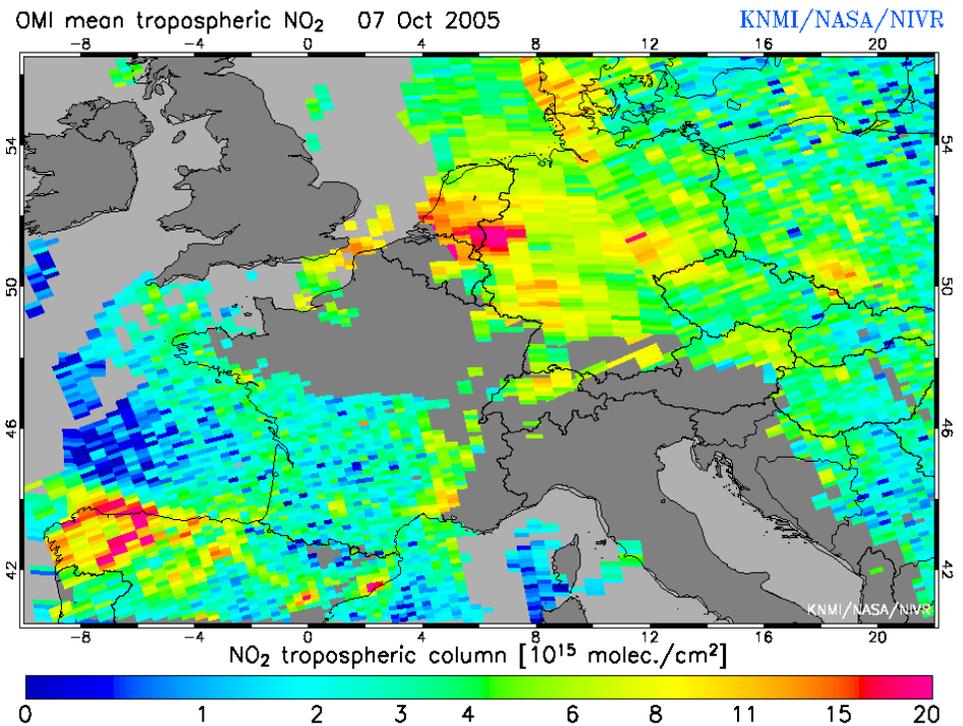
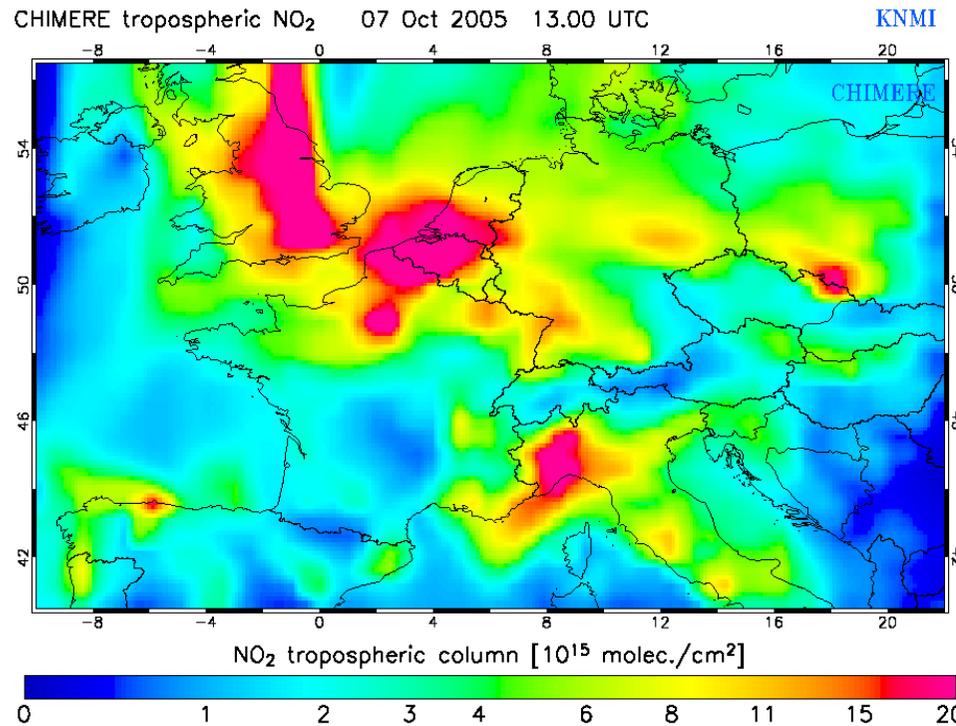
Stripe correction



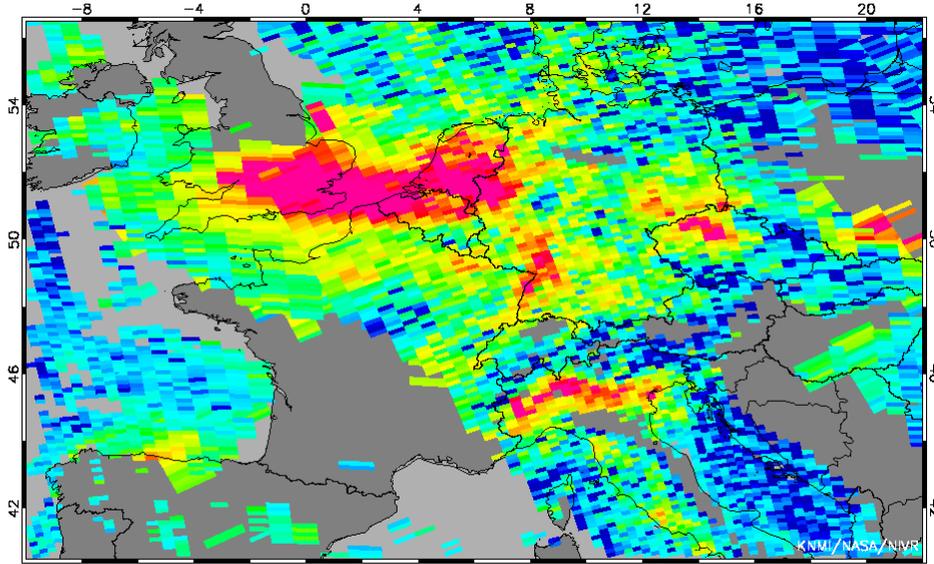


Comparison with CHIMERE

Cloudy pixels masked



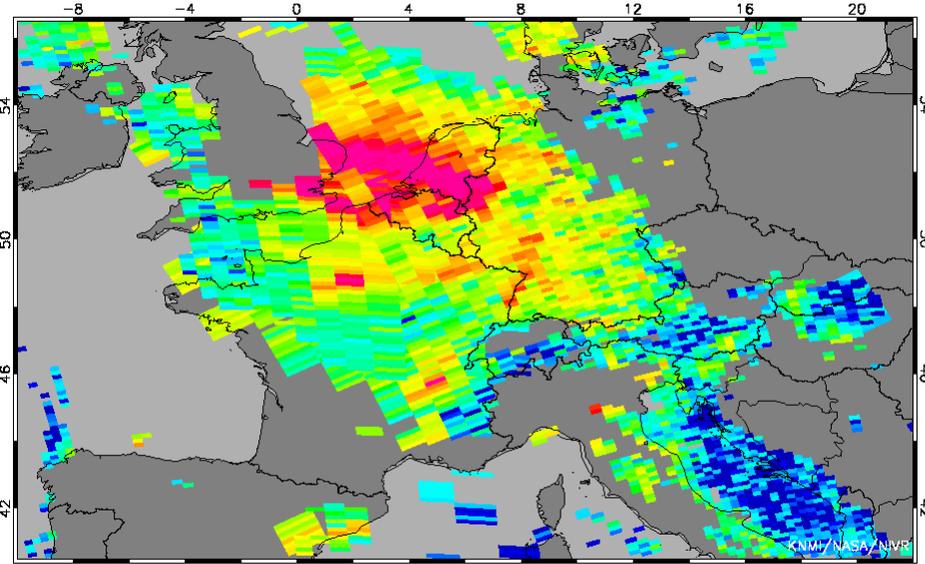
OMI mean tropospheric NO₂ 15 Oct 2005 KNMI/NASA/NIVR



NO₂ tropospheric column [10^{15} molec./cm²]



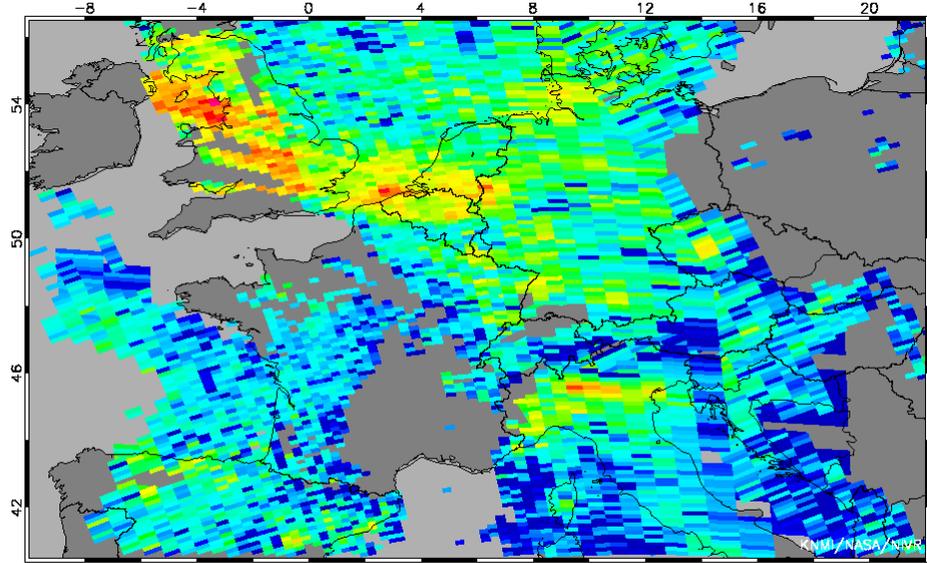
OMI mean tropospheric NO₂ 17 Oct 2005 KNMI/NASA/NIVR



NO₂ tropospheric column [10^{15} molec./cm²]



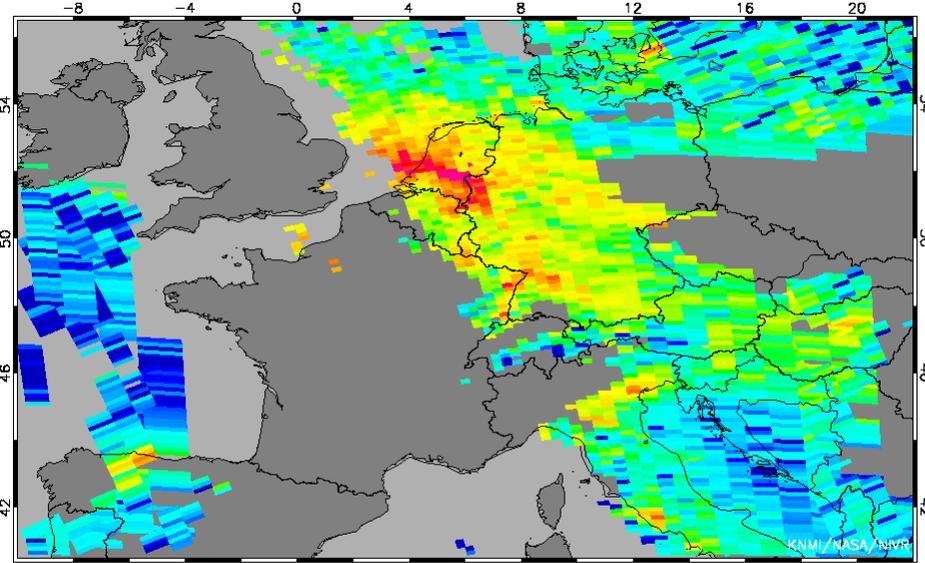
OMI mean tropospheric NO₂ 16 Oct 2005 KNMI/NASA/NIVR



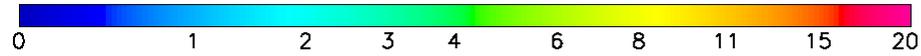
NO₂ tropospheric column [10^{15} molec./cm²]



OMI mean tropospheric NO₂ 18 Oct 2005 KNMI/NASA/NIVR



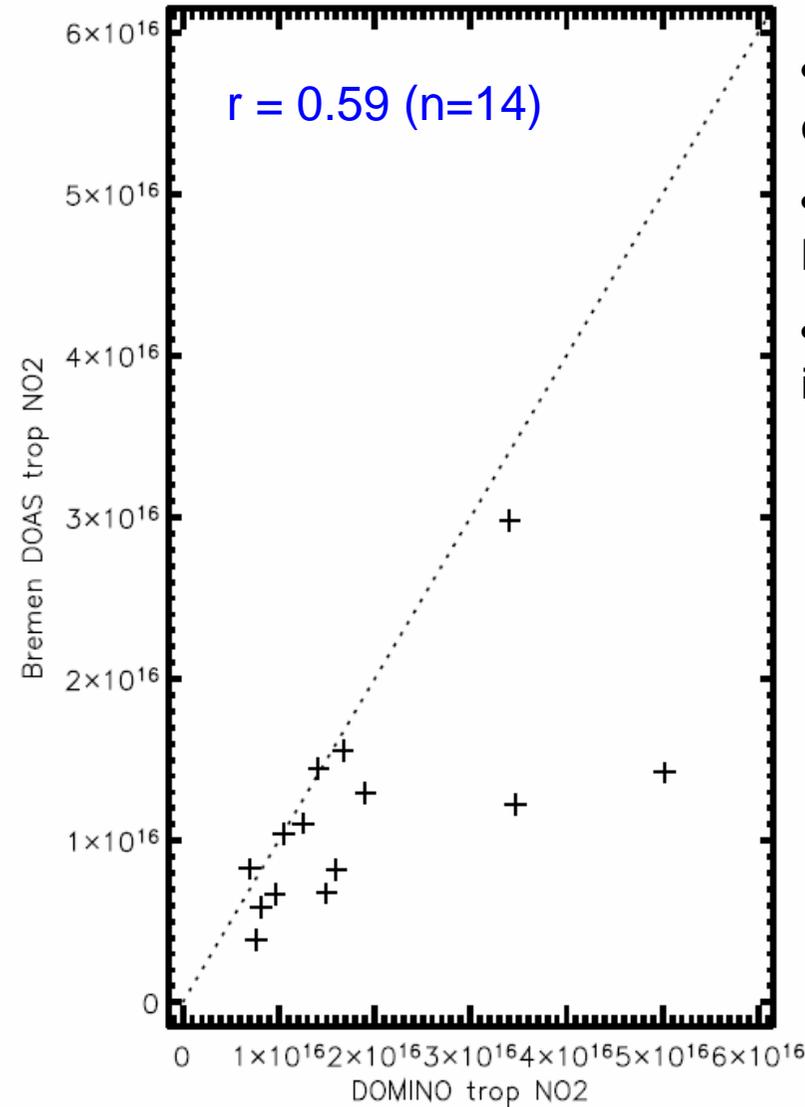
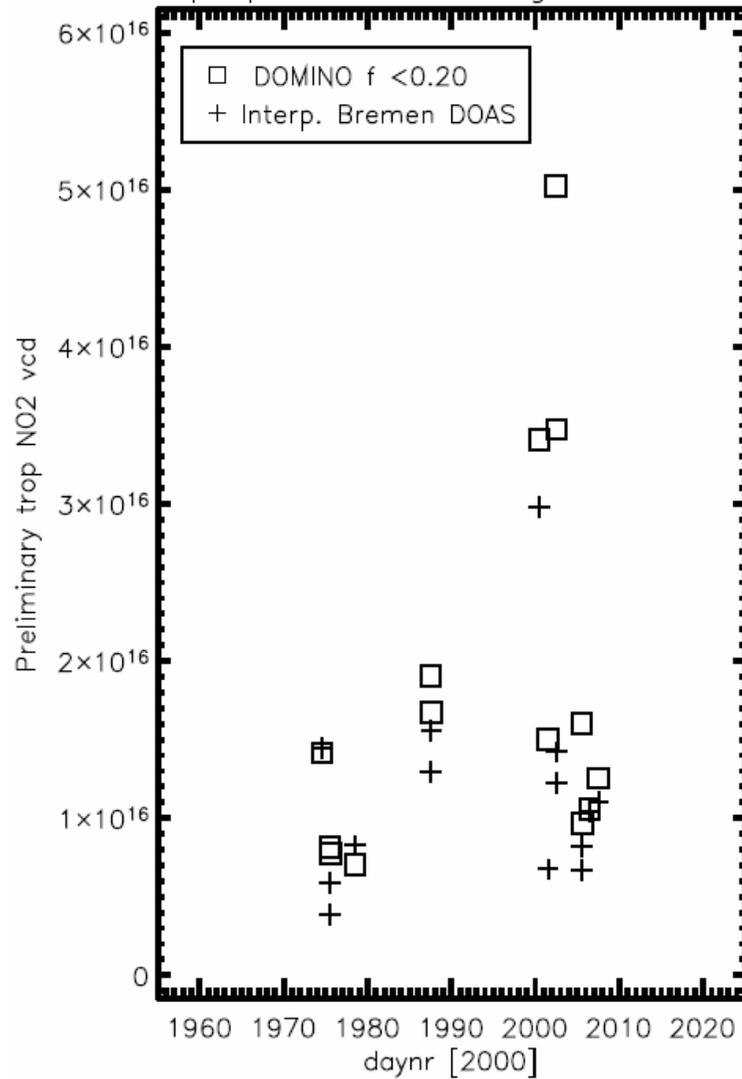
NO₂ tropospheric column [10^{15} molec./cm²]





Dandelions validation (in progress)

Tropospheric NO₂ during DANDELIONS



- 14 separate orbits
- DOMINO > MAXDOAS
- Representativity issues

3 november 2005



Conclusions

- OMI NO₂ near-real time retrieval operational
- Initial comparisons to: - CHIMERE
- MAXDOAS

Outlook

- Validation vs. SCIAMACHY and official OMI NO₂ product
 - clouds
 - stripe correction





1. 'Rural' comparison

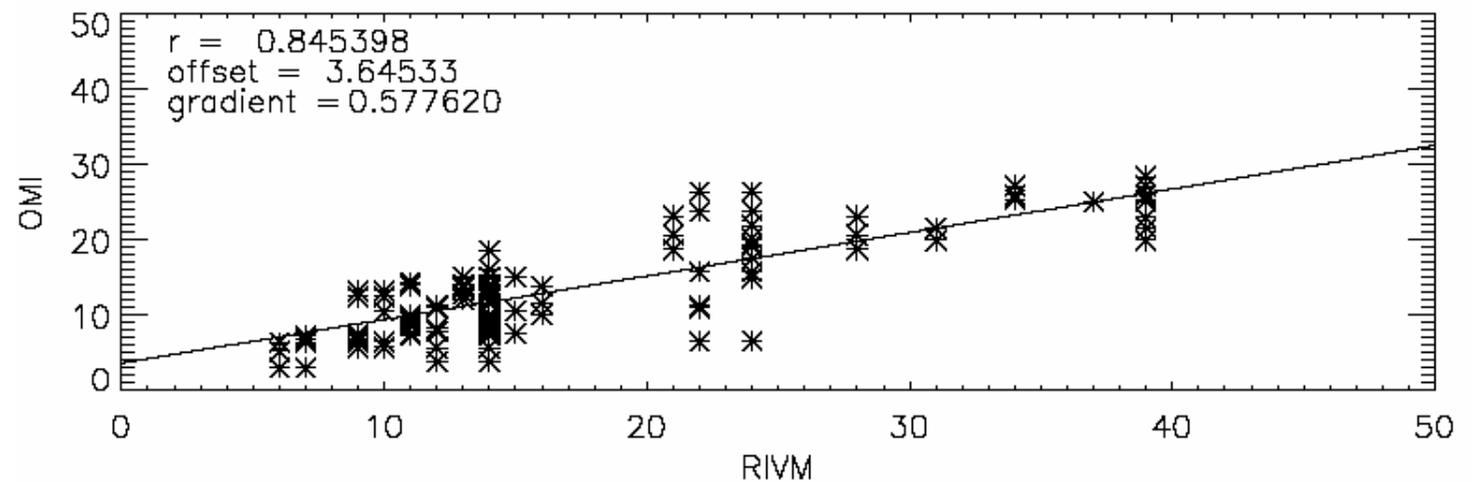
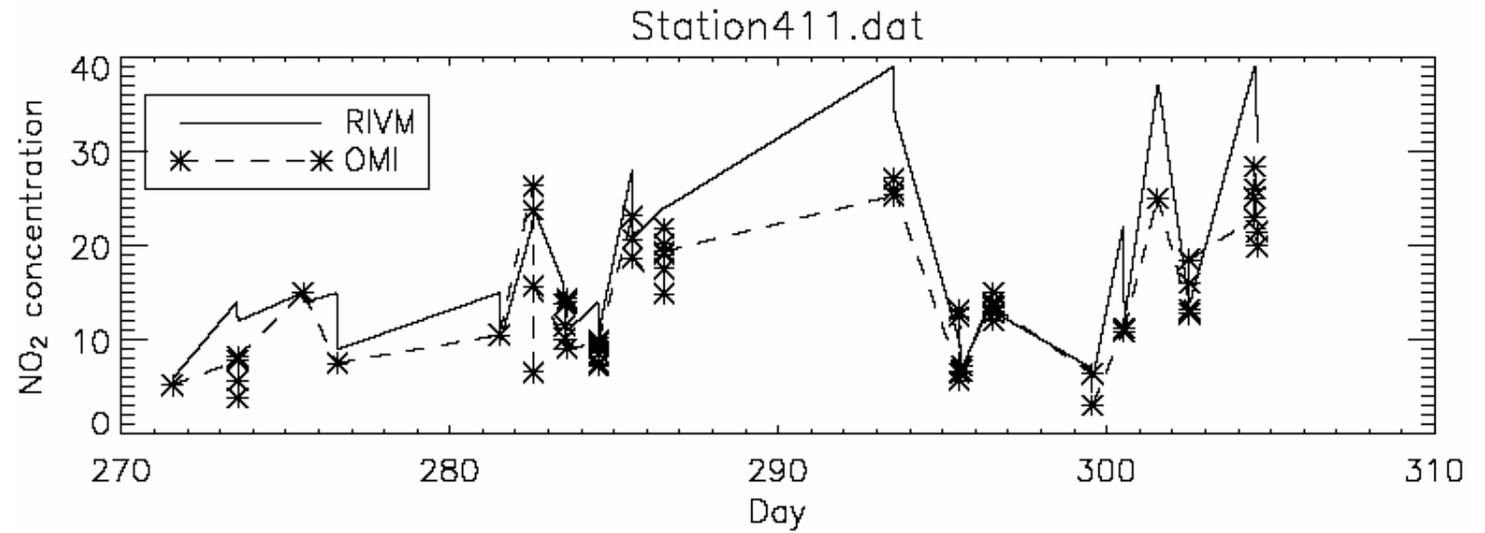
Criteria

- OMI pixel $w < 50\%$ ($f_{cl} < 0.2$)
- $|\Delta t| < 1$ hr
- $|\Delta r| < 25$ km



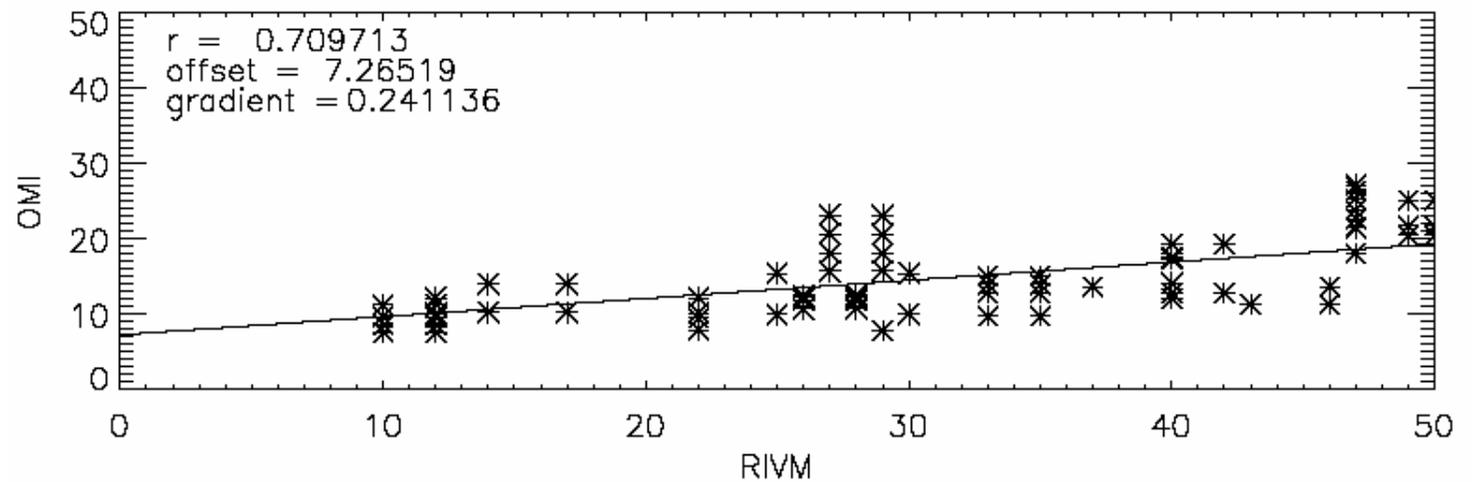
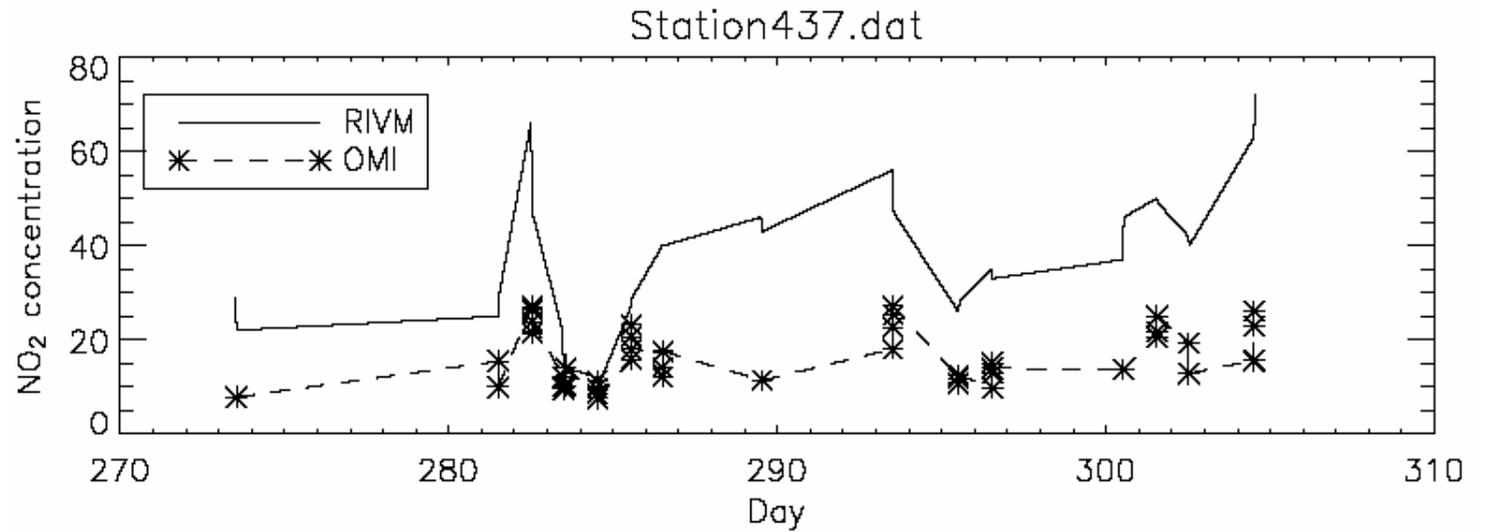


'Rural' comparison – Schipluiden



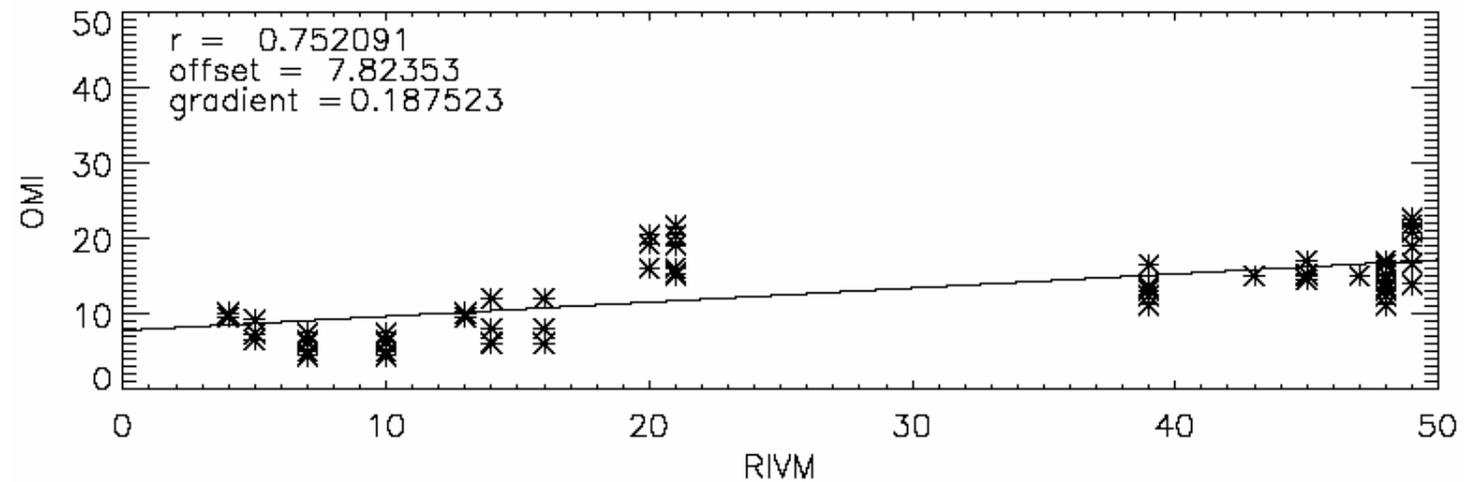
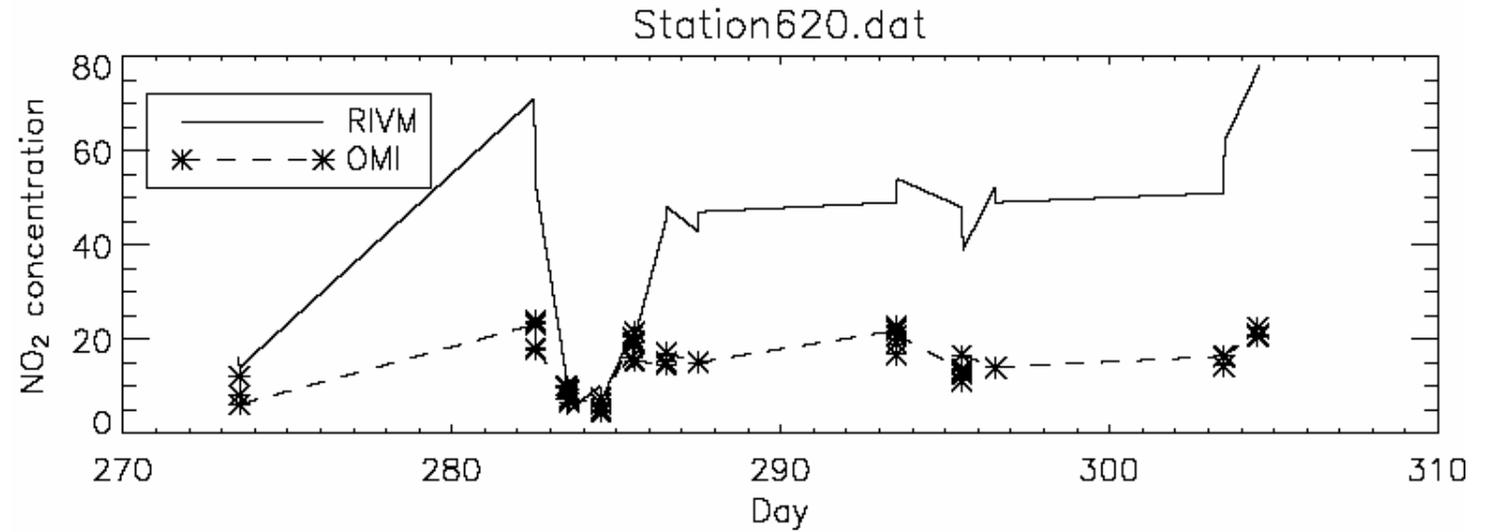


'Rural' comparison – Westmaas





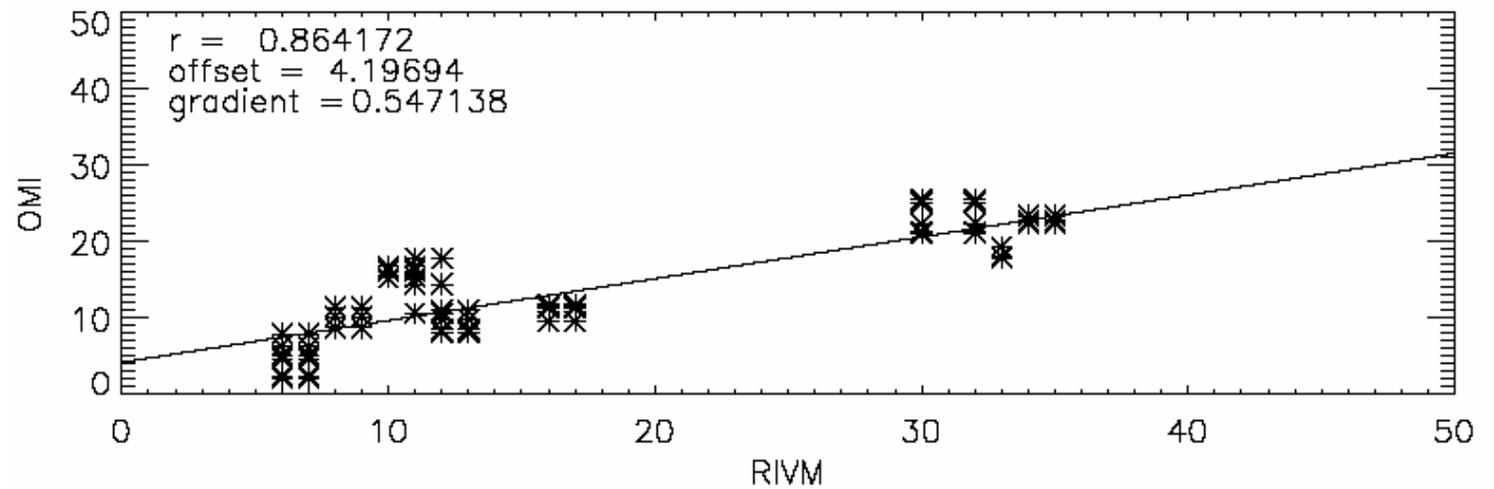
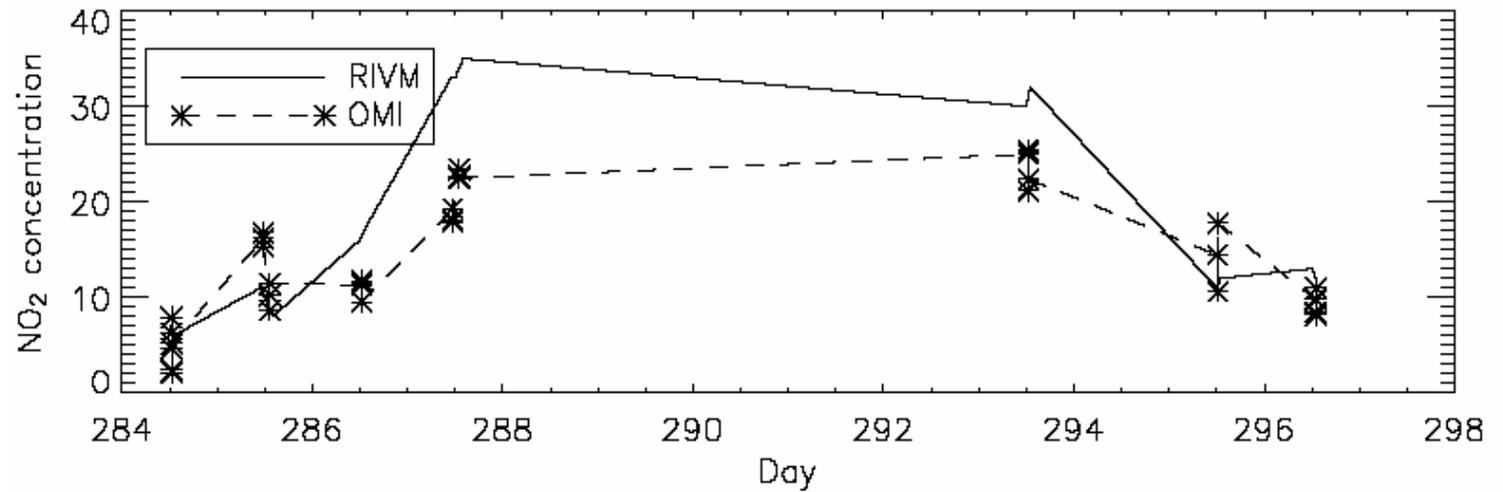
'Rural' comparison – Cabauw





'Rural' comparison – Hellendoorn

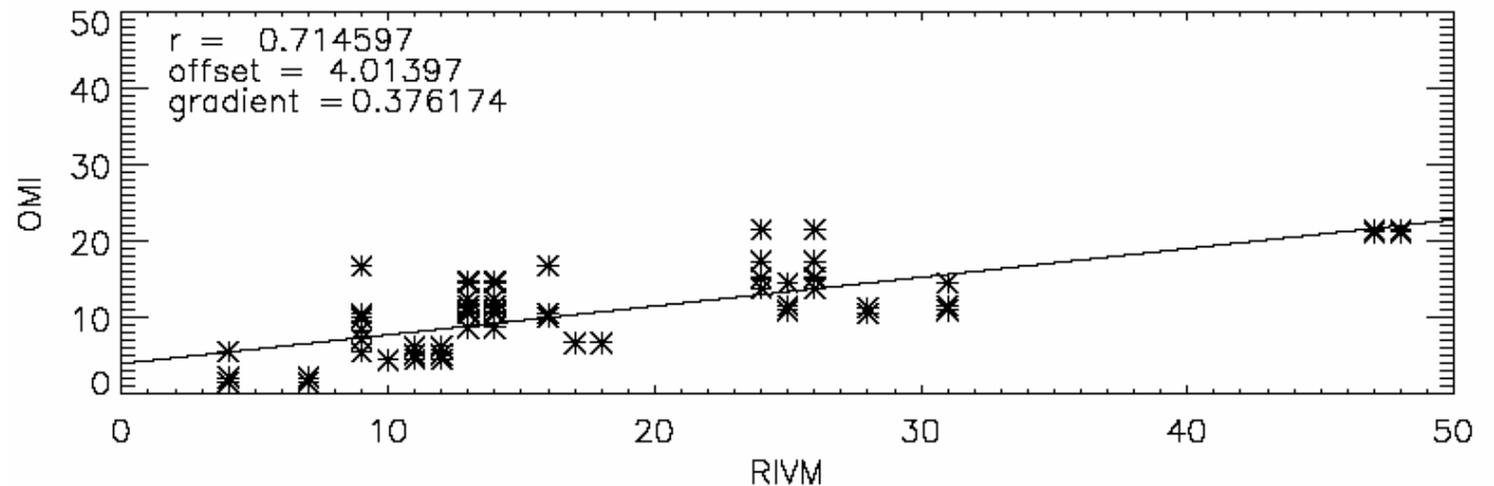
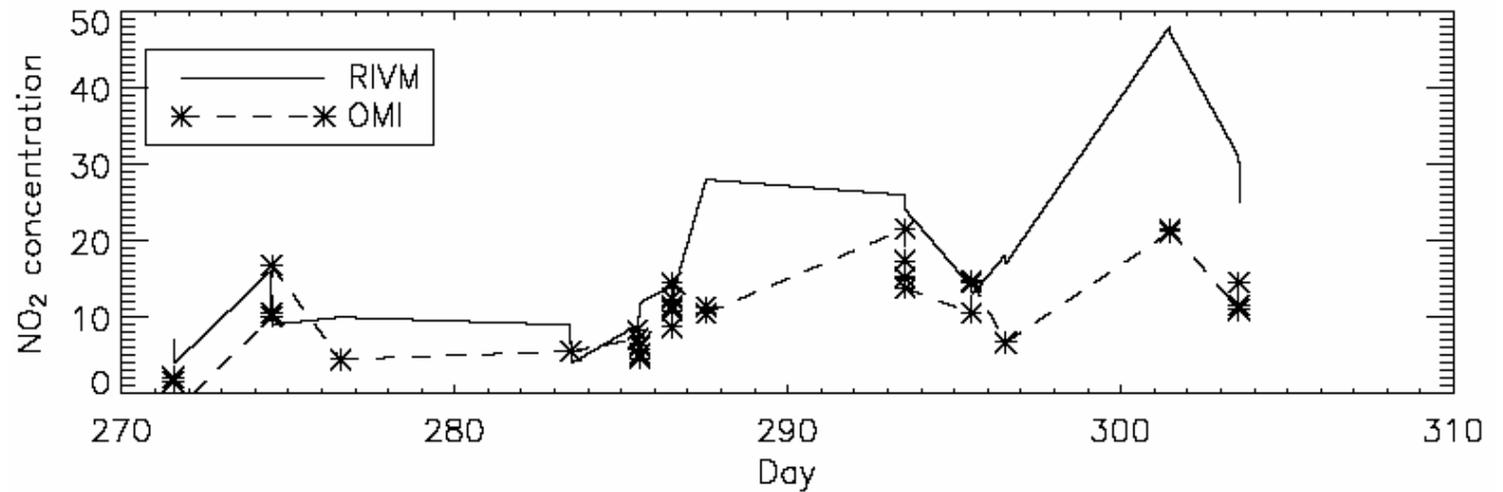
Station807.dat





'Rural' comparison – Kollumerwaard

Station934.dat





'Rural' comparison

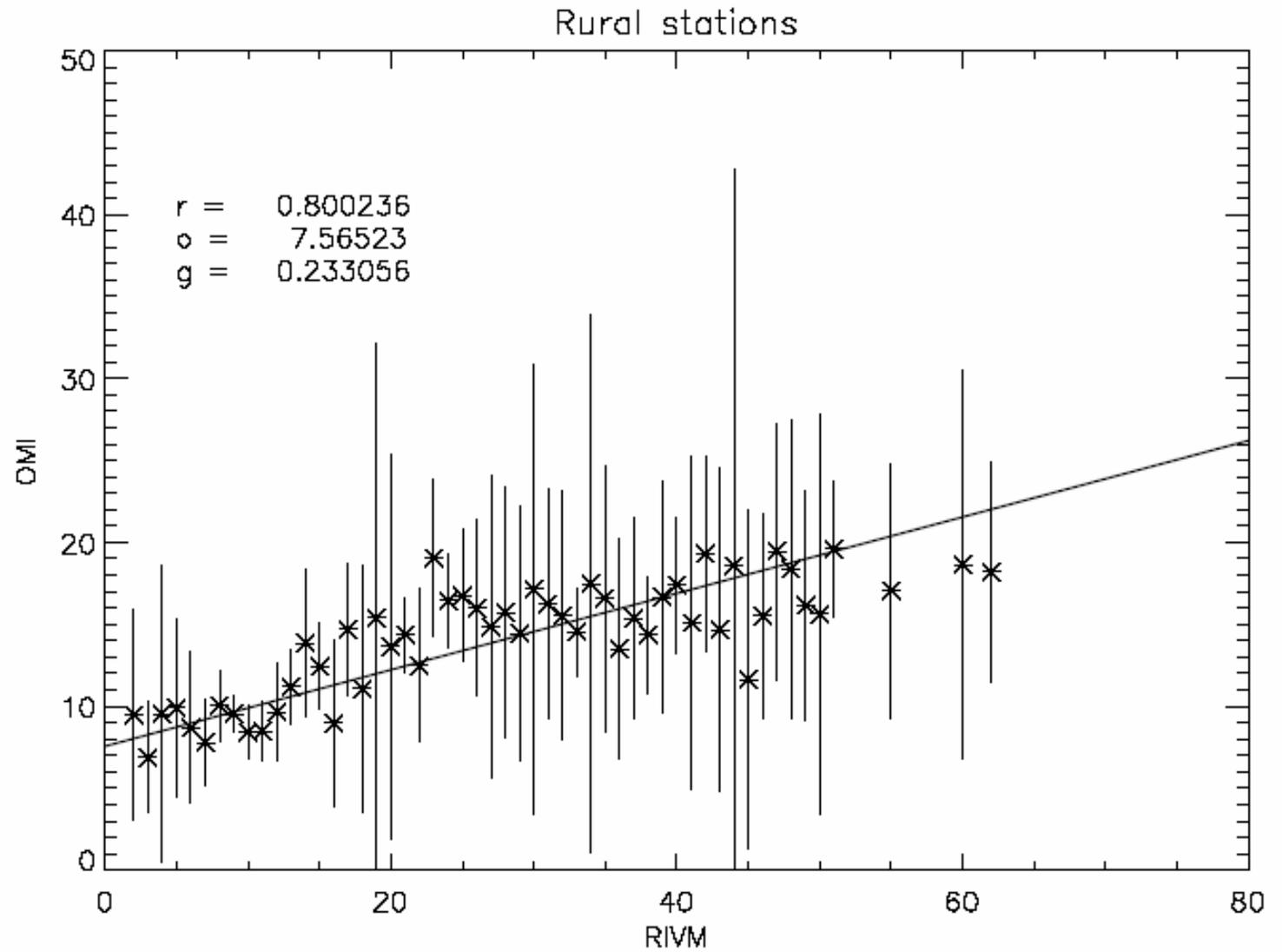
All stations (>20)

- Calculate average OMI column for corresponding to surface concentrations
- Standard deviation of the mean is a measure for uncertainty on OMI average
- Calculate correlation coefficient
- Calculate weighted least square fit $y = a + bx$



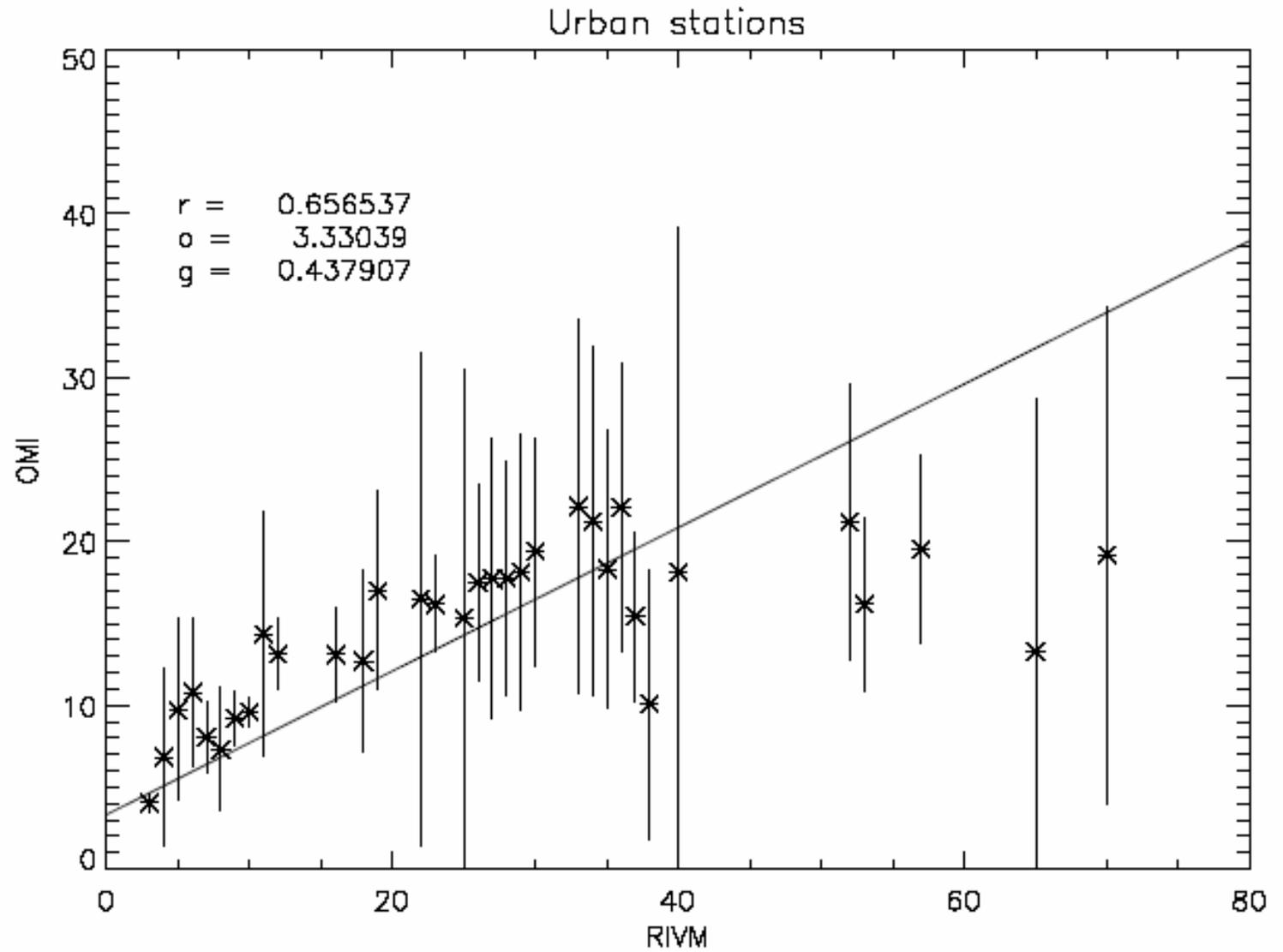


'Rural' comparison



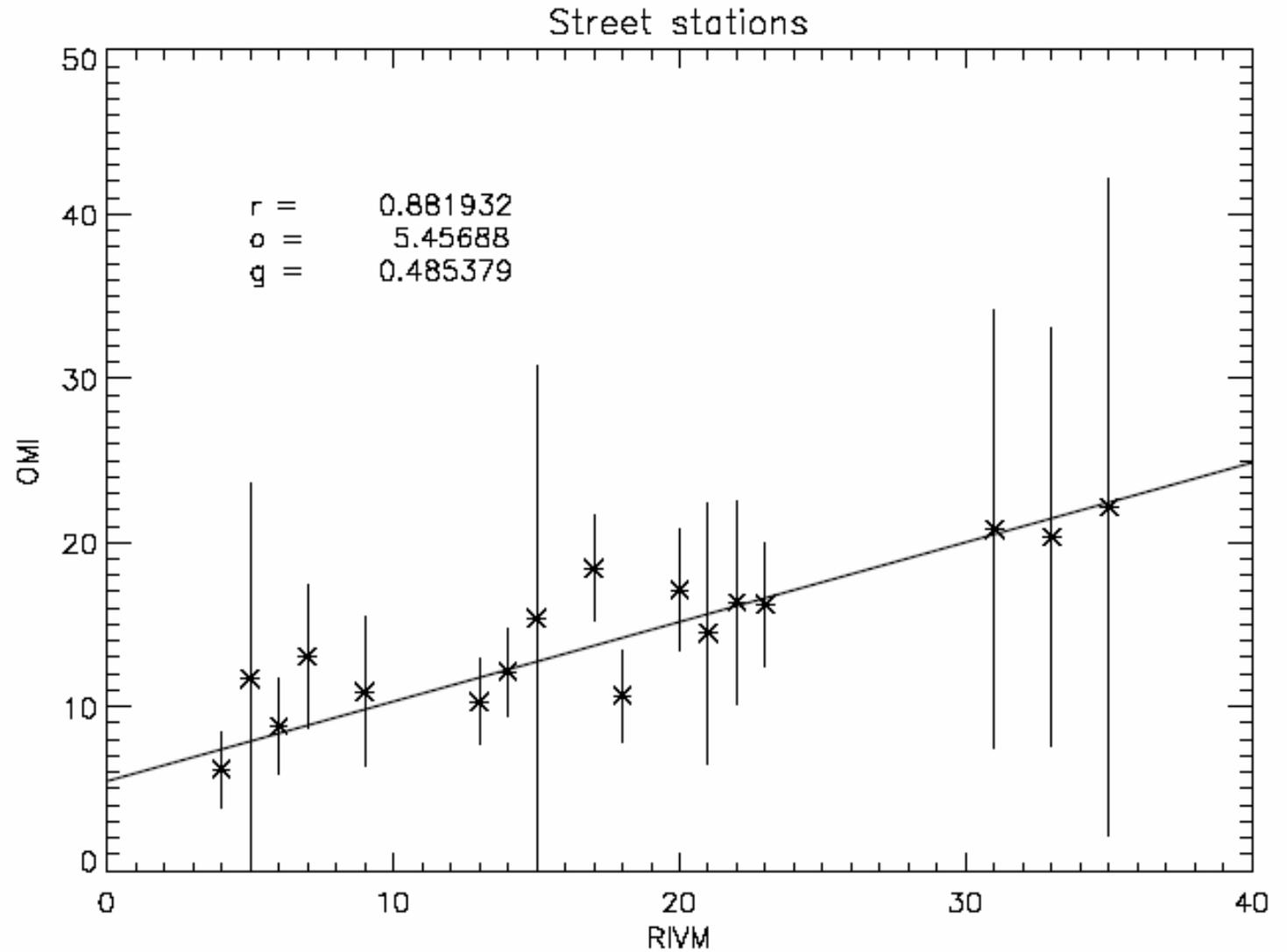


'Urban' comparison





Street station comparison





Preliminary conclusions

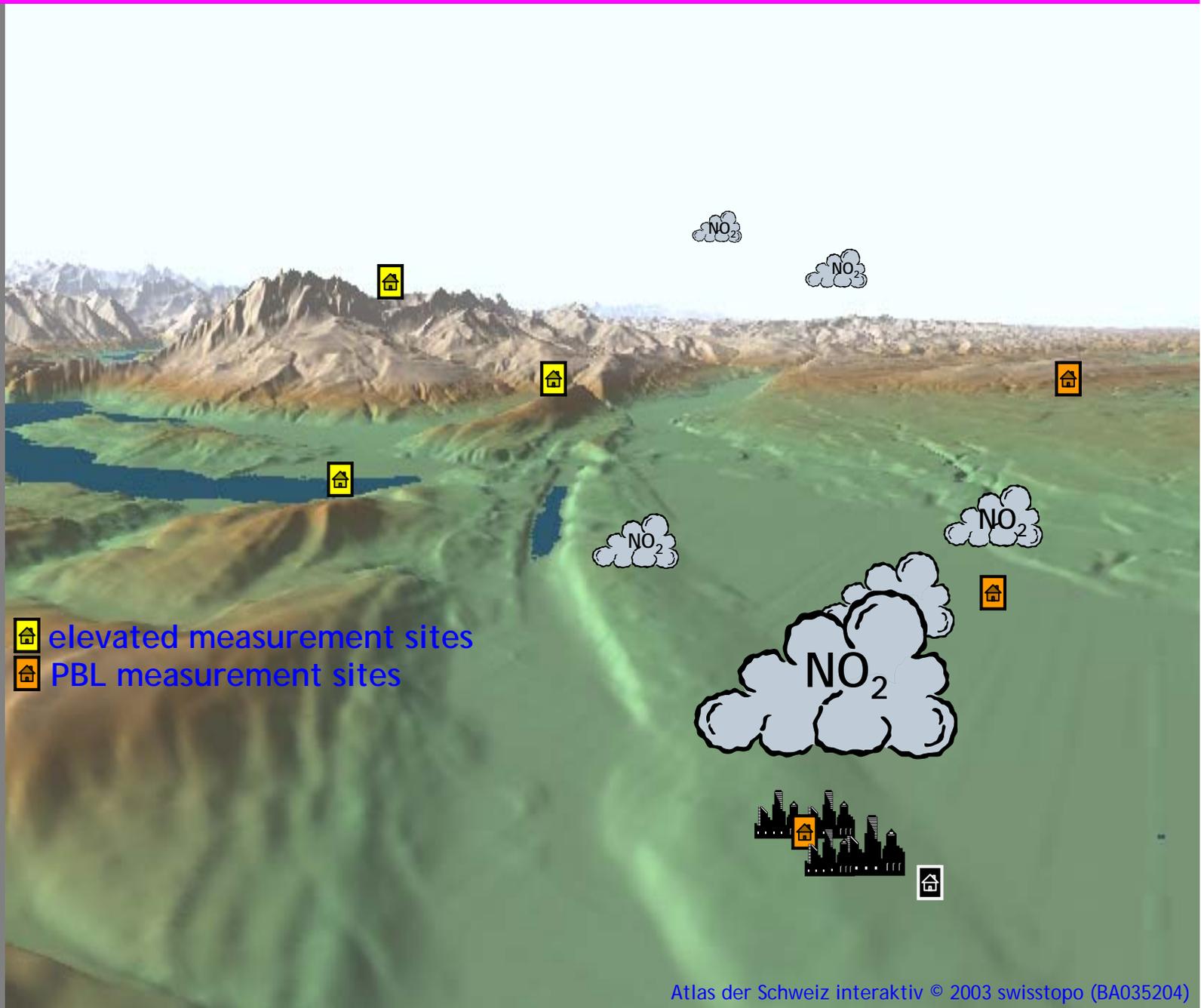
- First (Dutch) OMI NO₂ 'validation' result of 'old'
- For NL: good average correlations ($r = 0.6-0.9$)
- Clear relationship between surface NO₂ conc. and OMI columns

Discussion

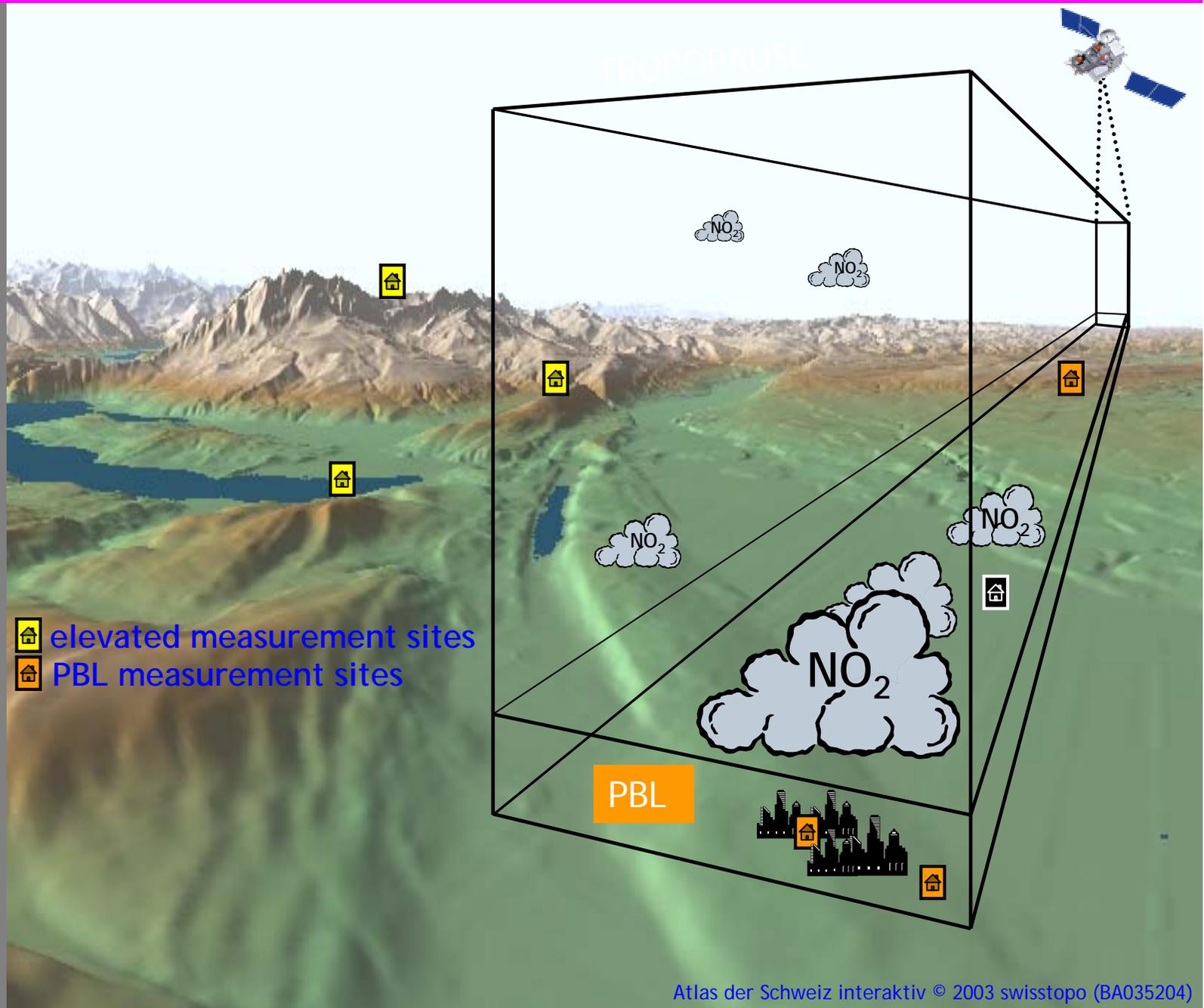
- Offset too large: $3-7 \times 10^{15}$ molec. cm⁻²
- Use boundary layer height to convert conc. → column
- 'Old' OMI dataset (new OPF, cloud algorithm improvements)



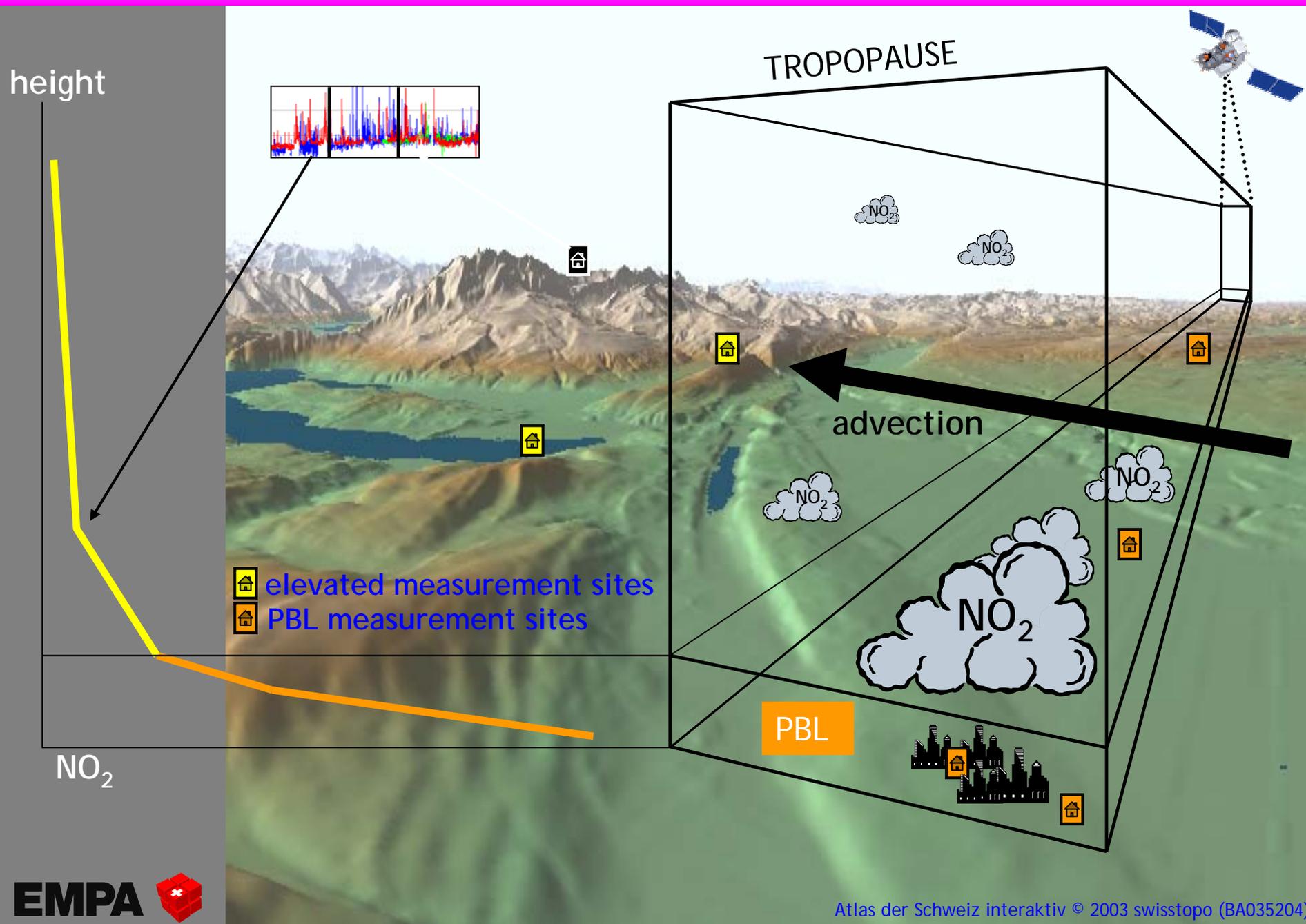
2. Column comparison ground-based in-situ ↔ space-borne



2. Column comparison ground-based in-situ ↔ space-borne



2. Column comparison ground-based in-situ ↔ space-borne



••••

2. Comparing GOME and in-situ 'profiles'

GOME:
$$x_S = \frac{N_s}{M(\mathbf{x}_a, \mathbf{b})}$$

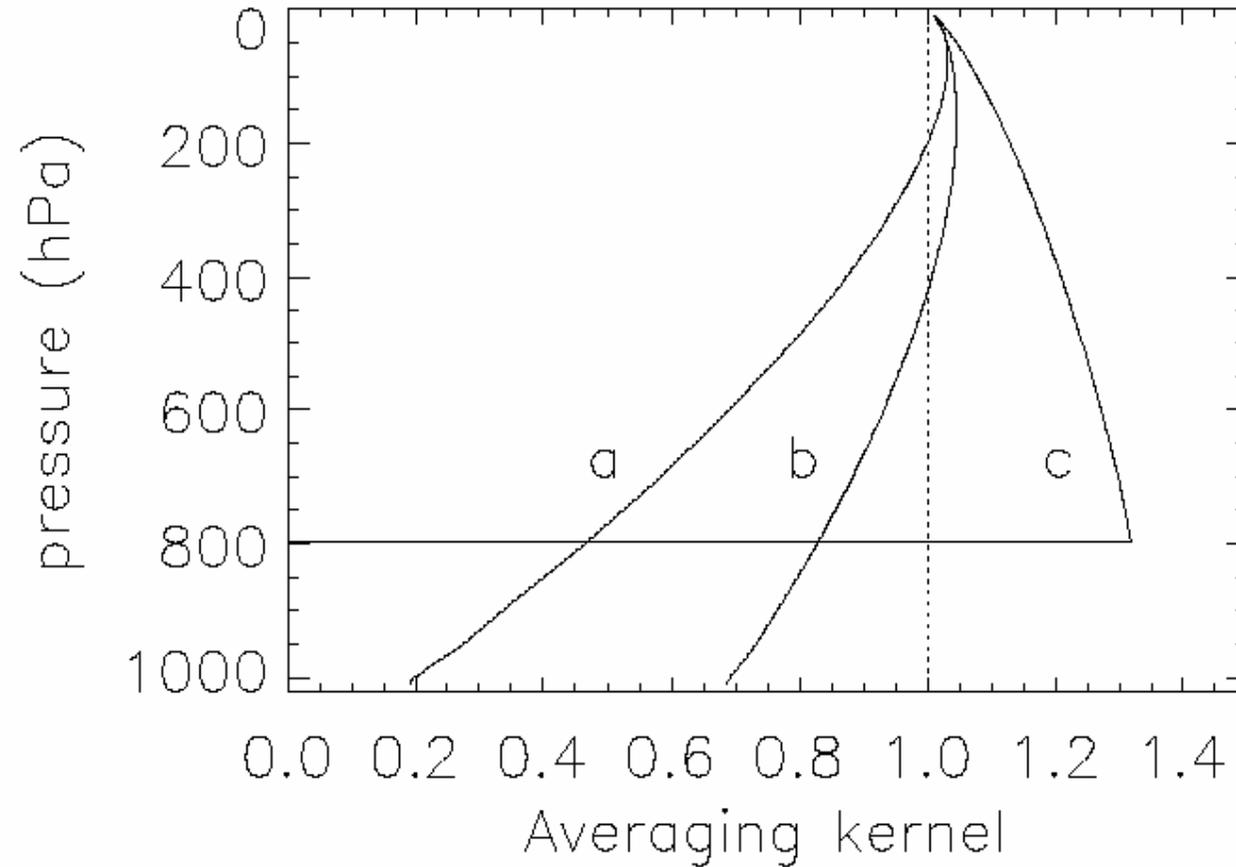
Validation:
$$x_V = \mathbf{A} \cdot \mathbf{x}_L \quad \text{with} \quad \mathbf{A} \cdot \mathbf{x}_L = \frac{\sum_l m_l(\mathbf{b}) \cdot x_{L,l}}{M(\mathbf{x}_a, \mathbf{b})}$$

GOME/Validation:
$$\frac{x_S}{x_V} = \frac{N_s}{\sum_l m_l(\mathbf{b}) \cdot x_{L,l}}$$

For every collocation comparison through the kernel



2. Averaging kernel

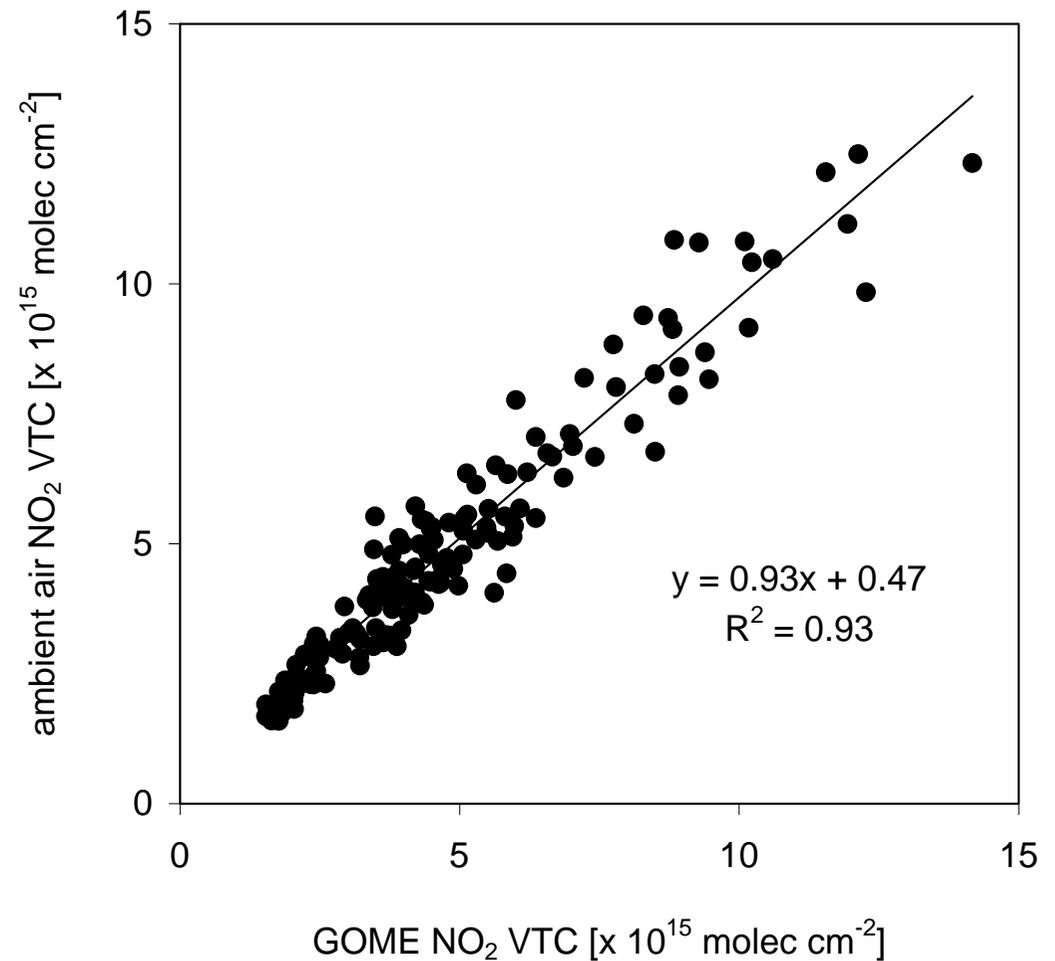


- a) alb = 0.05
- b) alb = 0.20
- c) cloud at 800 hPa



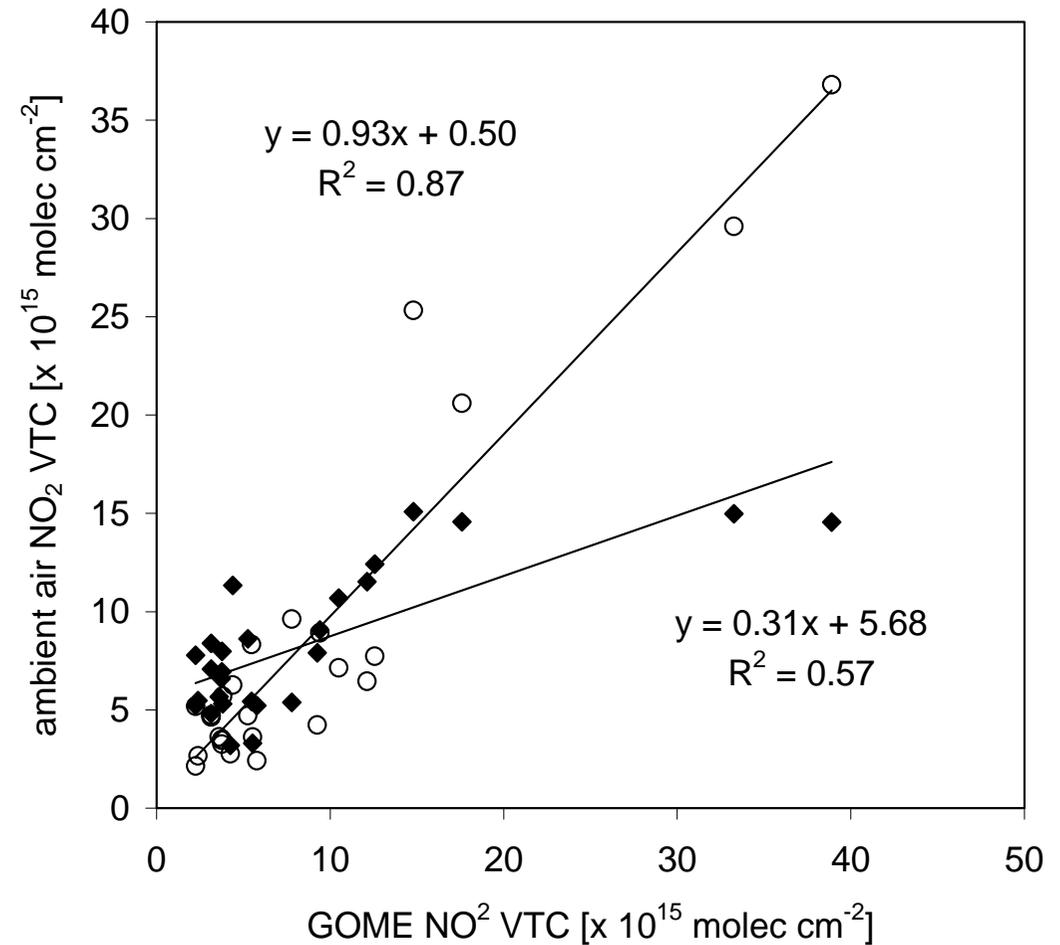
2. GOME NO₂ validation – cloud-free

- GOME 1996-2003
- Cloud-free scenes
- n~100



2. GOME NO₂ validation – cloud-covered

- GOME 1996-2003
- Cloud-covered scenes
- n~25
- open: via kernel
- solid: vertical integral





2. Conclusions

- Vertical profiles can be constructed from in-situ ground-based data
- Validation through kernel →

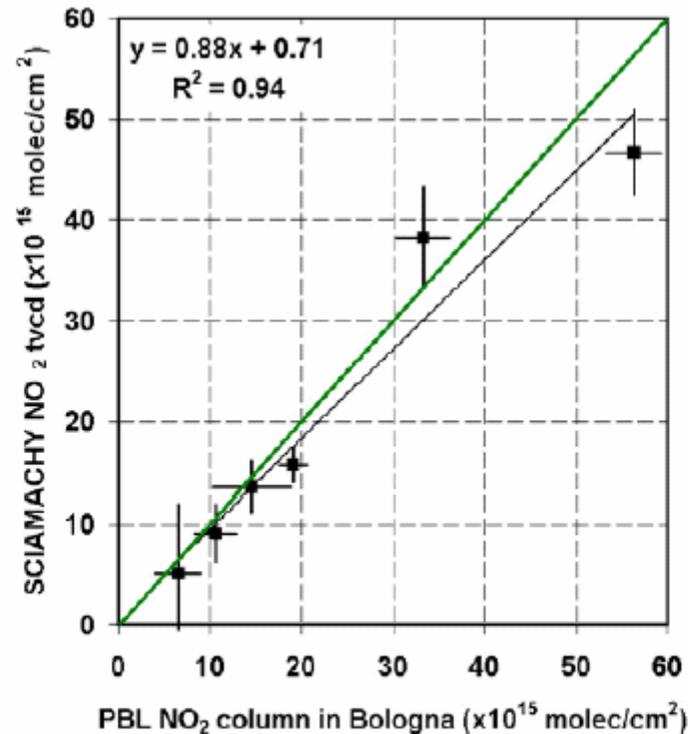
Comparison becomes independent on a priori profile

- Preliminary results show excellent agreement
- Representativity issues →

What part of difference is caused by differences in temporal/spatial sampling?

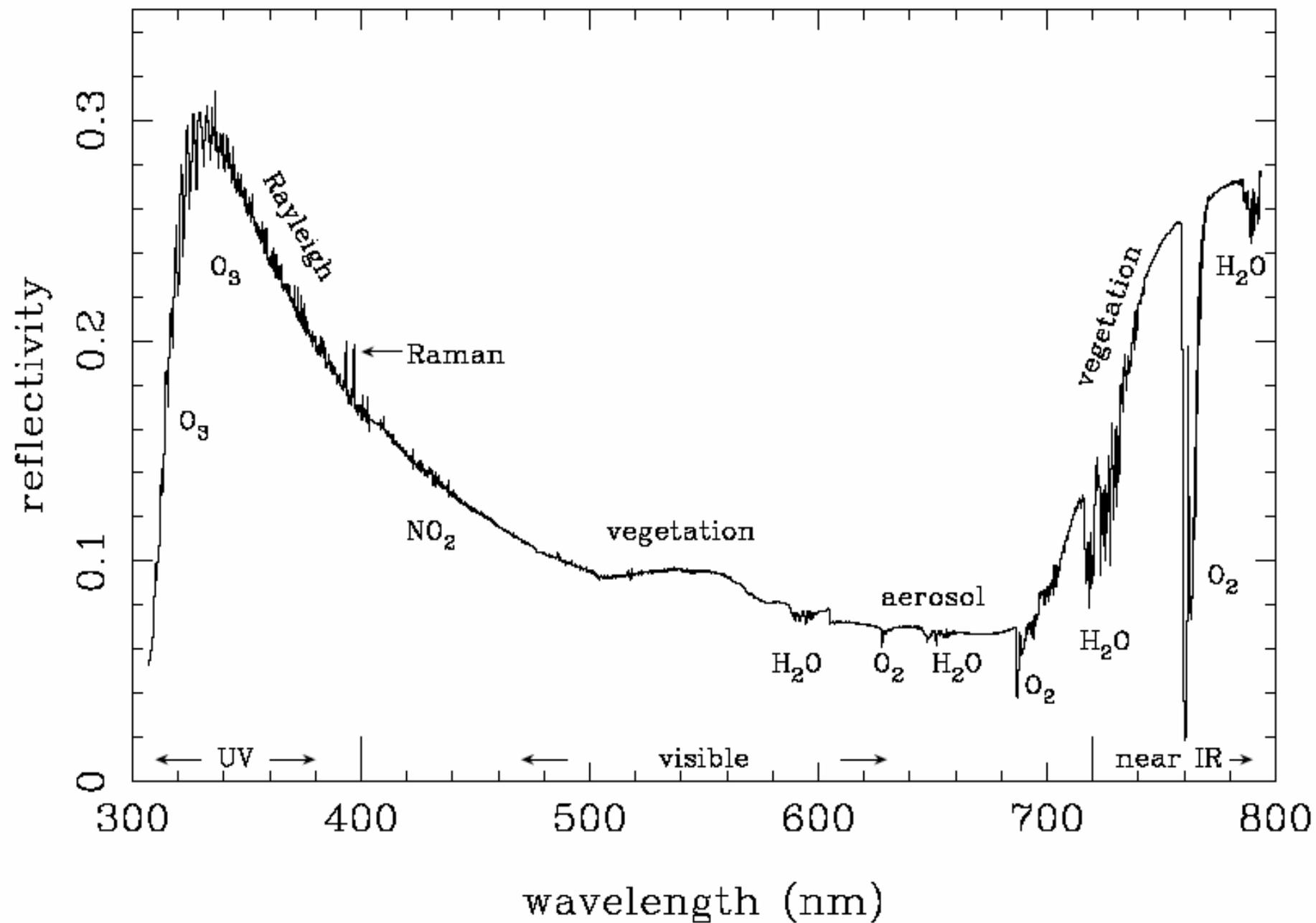


Comparison SCIA – ground-based DOAS Bc



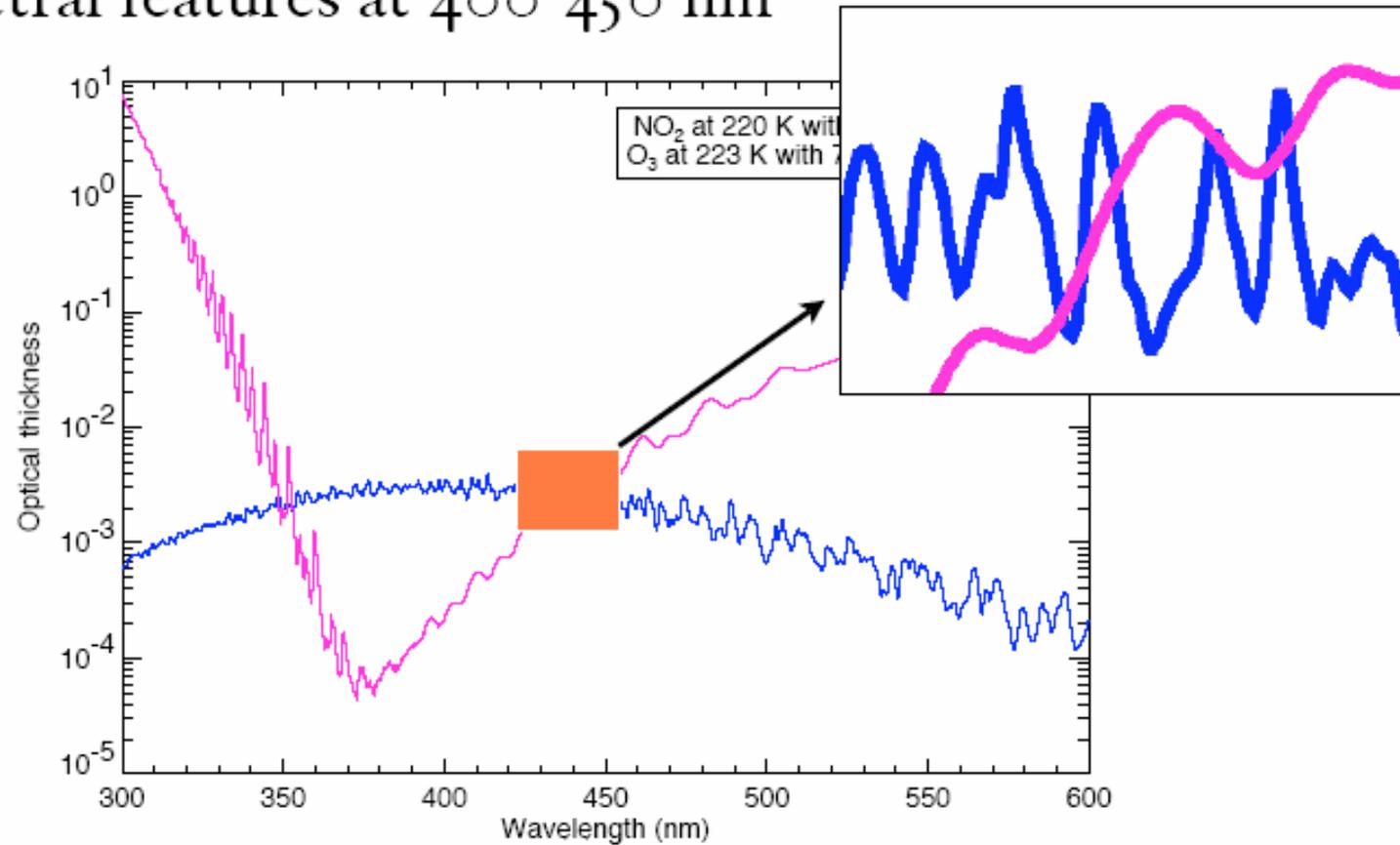
Petritoli et al., 2005

Fig.1: Comparison between tropospheric column measurements of NO₂ obtained by SCIAMACHY and PBL column measurements obtained by GASCOD for some selected days of 2003 after the corrections for horizontal gradient effect.





Spectral features at 400-450 nm



• Good signal to noise (~20)



OMI PFM Zenith Sky August 16, 2002

